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Strengthening climate change adaptation capacity in Africa- case studies from six major African cities and policy implications

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ABSTRACT

Africa is one of the most vulnerable regions in respect of climate change. As the African continent struggles to adapt to climate change, a variety of measures are being pursued to alleviate the resultant pressures on people, properties and their livelihoods in several African cities. Collectively, they show that climate change adaptation in Africa is not as hopeless as widely claimed, and that there are some promising prospects. The literature shows a deficiency on studies which examine the extent to which climate change adaptation is being pursued in African cities. This paper addresses this need, and outlines some of the most important climate threats (e.g. increasing temperatures, droughts, sea level rise, sea and river flooding) and synergic non-climate factors, as well as recent progress made in respect of implementing climate change adaptation in African cities. Rather than adopt a general description of trends, this research focuses on concrete case studies from six major cities across the central, western, and eastern regions of the African continent (Douala, Lagos City, Dar-es-Salaam, Accra, Addis Ababa and Mombasa). The vulnerability and adaptive capacity status of the studied cities are discussed. Difficulties and challenges encountered in implementing adaptation policies in these areas are also highlighted. Furthermore, some successful examples of climate change adaptation initiatives in the surveyed cities are provided. Finally, the paper outlines some of the policy measures which can be implemented towards strengthening the capacity of African cities to adapt to a changing climate.

1. Introduction

Scientific evidences on weather patterns across many parts of the globe indicate a changing climate (Dodman, 2011; IPCC et al., 2012; Wilson, 2014), particularly in respect of an increase in extreme events worldwide since 1950 (Herring et al., 2014; Hulme, 2014). Africa has been identified as highly vulnerable to climate change and variability (IPCC, 2007a; Epule et al., 2017). This is largely due to economic and social problems and multiple stressors, which exacerbate the exposure and sensitivity across the continent to weather and climate extremes. The impacts of climate change are felt at various spatial scales but responding to climate change in African cities is challenging. There is a dearth of scientific works focused on the impacts of climate change in African cities (Nkhonjera, 2017). Most existing works on Africa focus on the more developed Southern Africa sub-continent (Klausbruckner et al., 2016; Novellie et al., 2016; England et al., 2018) while there is a proportionally sparse number of scientific works on other regions of the African continent, which are relatively less developed and more vulnerable. This paper tries to address this gap by focusing on concrete examples from cities across western, eastern and central Africa including Cameroon, Nigeria, Tanzania, Ghana, Ethiopia and Kenya.

The impacts of climate change are expected to be higher in cities

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that have a low adaptive capacity due in part to limited resources, social and institutional networks, technology, the level of human development and political will of governments (UNEP, 2011). Even though climate risks are often discussed at the national scale, urban areas are increasingly seen as having a pivotal role in the climate agenda. At present, decision-makers face significant challenges when adopting suitable strategies in respect of adaptation action, and the tools to be used to reduce losses and damages arising from climate hazards including (ND-Gain, 2017):

- Uncertainty of urban climate hazards
- Lack of reliable data/measurements to prioritize adaptation actions
- Limited availability of data to understand and track urban vulnerability to climate change
- Difficulties in integrating scientific information into future legislation and adaptation procedures

As one of the Sustainable Development Goals (SDGs), Climate Action proposes to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters (United Nations, 2015). Urban areas are known to be particularly susceptible to external shocks and stresses. Therefore, cities are expected to increasingly experience climatic effects in the form of more intense and frequent extreme weather events. This will put millions of people at risk, especially the poor, who are particularly vulnerable (UN-Habitat, 2015). Since social, economic, and environmental sustainability can be improved by the disaster risk management and adaptation approach, addressing the fundamental causes of vulnerability is a prerequisite for sustainability in the context of climate change (IPCC et al., 2012).

Presently, many governments across the African continent work in complex political contexts, struggling to meet service delivery backlogs within largely poor local communities. Poverty is widespread in many African countries, which further compounds the devastating effects of climate change. Local authorities assume that poor people in urban areas can cope and recover easily from climatic and non-climatic shocks and stresses as compared to their rural counterparts, which is not always the case (UNHSP, 2003; Murambadoro, 2007; Adenle et al., 2017).

Due to a combination of inadequate governance systems and economic hardships, many local authorities across African cities struggle to cope with the intensive migration seen from rural areas to cities. It is assumed that urban populations can cope and recover easily from climatic and non-climatic shocks and stresses in comparison to their rural counterparts. However, this might not be necessarily true due to the relative complexities of urban livelihoods, which ultimately influence the adaptation strategies that are adopted (Murambadoro, 2007). Unfortunately, there have been limited in-depth analyses of what African cities are doing to adapt (Cabral et al., 2017; Nkhonjera, 2017), which makes it difficult to appraise existing strategies. Epule et al.'s (2017) work focused on the Sahel, which are mainly desert Northern regions of different African Countries. This work chronicled national and regional level interventions, rather than city level initiatives. Thus the following questions arise:

- Are the vulnerability and adaptive capacity of African countries and cities commensurate with their exposure, economic and socio-economic development status?
- Are existing climate change strategies and policies adequately addressing the vulnerability and adaptive challenges of African cities?

The aims of this paper, which provides a novel approach in studying the extent to which climate change impacts African cities, are threefold: (i) to review climate change impacts in major African cities through six case studies (Douala, Lagos, Dar-es-Salaam, Accra, Addis Ababa, and Mombasa), ii) to make a cross-comparison of adaptation measures and strategies, and iii) to list a set of lessons learned and recommendations which may help to improve current trends.

2. Climate change impacts in African cities

Climate change is one of the major problems currently facing cities globally. Various projections suggest an increase in both the frequency and magnitude of extreme weather events (IPCC et al., 2012). Despite their high level of vulnerability, African cities are underrepresented in climate change research and assessments of successful adaptation initiatives (Cabral et al., 2017; Nkhonjera, 2017). This is partly because local climate change challenges, vulnerabilities, priorities, and intensities are diverse, varying across countries (Simon and Leck, 2015; Moyo and Nangombe, 2015; Henderson et al., 2017).

Several coastal cities in western Africa are vulnerable to climate-related impacts such as flooding, erosion, heat waves, storm surges, sea-level rise, saline intrusion, and cyclones, all of which are projected to increase in coming years with economic implications (UN-Habitat, 2014). A warming of (1.5–3) °C, which is expected for 2050–2099 (Lawson, 2016; Henderson et al., 2017) will exacerbate current problems.

The Southern sub-region of Africa is experiencing warming and variation in weather, with a potential for increased droughts in future (IPCC et al., 2007b; UN-Habitat, 2014). Warmer conditions may help to promote the spread of crop pests and diseases, further increasing the burden of health risks in cities where the health systems are typically weak (Ebi and Burton, 2008). An increased incidence and severity of droughts has been documented, in addition to weather extremes which are projected to increase (Rakgase and Norris, 2015). Disasters triggered by warming, sea-level rise, storm surges, salinization of aquifers and precipitation have been identified as the cities´ major climate change hazards, coupled with droughts, cyclones, and erosion (Pasquini et al., 2013; UN-Habitat, 2014).

Extreme events coupled with sea-level rise pose serious hazards to cities in Eastern Africa too (Birhanu et al., 2016; UN-Habitat, 2014). Cities in the countries of the 'Horn' have the highest level of vulnerability (Moges and Gebregiorgis, 2013). Water shortages are regular occurrences in the inland cities, accompanied by extended and recurrent drought crises (Ogola et al., 2012) which have directly impacted 13 million people between 2008 and 2010. Historically, this sub-region has been fraught with droughts and floods, resulting in the loss of human lives, decimation of livestock, and gross reduction in the volume of agricultural produce (Ng'ang'a et al., 2016). Food insecurity and the outbreak of inter-communal violence often lead to the internal displacement of residents and proliferation of refugee camps (UN-Habitat, 2014). This context is further aggravated by the decrease in water availability index by 2015 in several East African cities (Nkhonjera, 2017).

North African cities are also threatened by drought and desertification due to temperature increase and a decline in rainfall, which leads to severe negative impacts on agriculture and a spike in demand for food imports (UN-Habitat, 2014). A decrease in precipitation from a range of 10 to 20% is expected from now until 2050 (Christoph et al., 2010), and many cities are further endangered due to the depletion of groundwater sources (UN-Habitat, 2014).

In the past 50 years, the agricultural sector in different cities has been affected due to a reduction in the availability of moisture (Henderson et al., 2017) and it is estimated that no less than 40% of the urban population in Africa is involved in agriculture (Dutt, 2016). In comparison to other continents, the projected impacts of climate change on agriculture are higher in Sub-Saharan Africa (SSA) (Amjath-Babu et al., 2016). Unless these climatic challenges are urgently addressed, intense rural-urban migration will likely be triggered, and there's the possibility of international migration in the long-term, spurred by desperation for survival (Marchiori et al., 2012).

3. Methods used

Six case studies of different African cities, and their respective

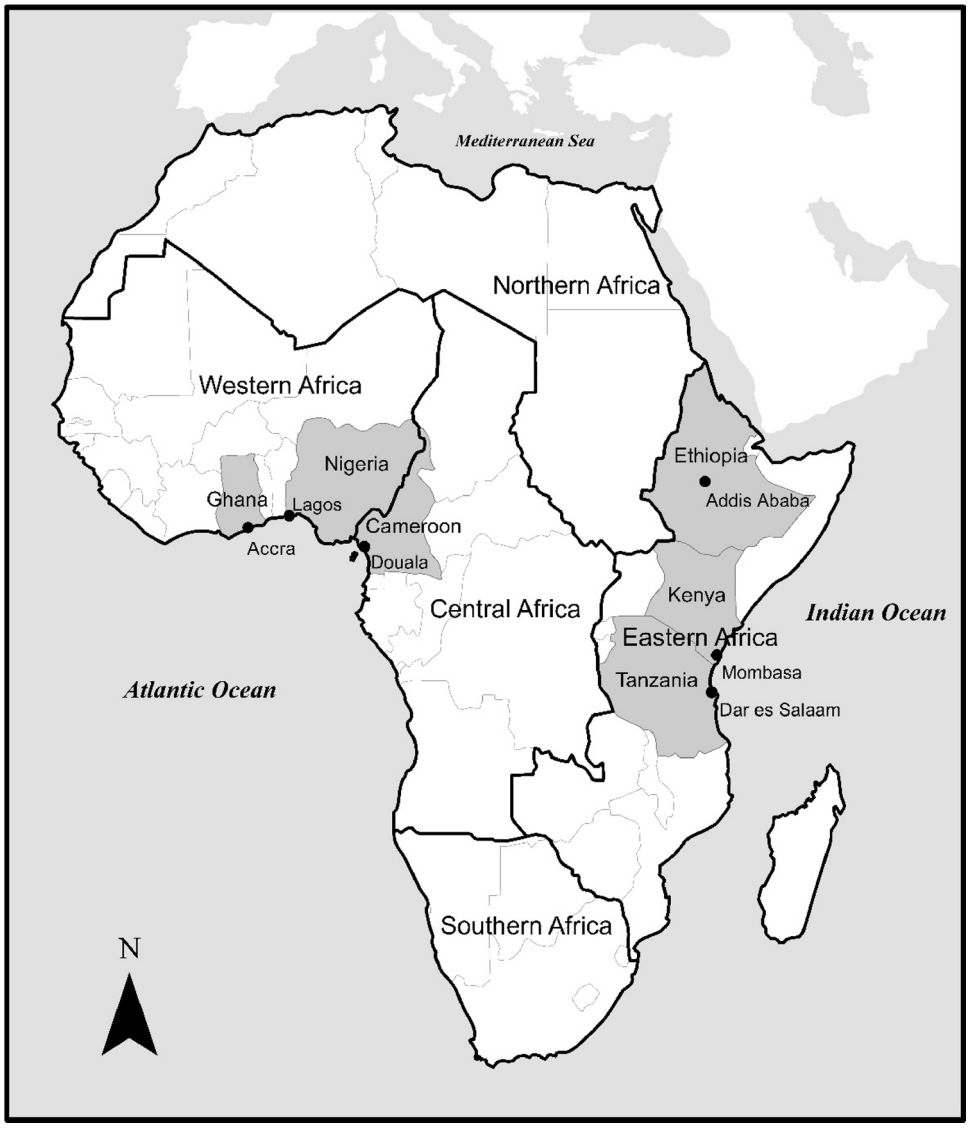

Fig. 1. Map of Africa highlighting sub-regions, countries, and cities.

climate change challenges and adaptation strategies, are presented in this section. The cities include: i) Douala, Cameroon in Central Africa, ii) Lagos, Nigeria, and iii) Accra, Ghana, in West Africa, iv) Dar-es-Salaam, Tanzania, v) Mombasa, Kenya, and vi) Addis Ababa, Ethiopia in East Africa (Fig. 1). The choice of this sample is a convenience one: the scientists who have taken part in this study are part of the International Climate Change Information Programme and many have contributed to the "Handbook of Climate Change Adaptation" (Leal Filho, 2015), having access to their respective data sets. The case studies were conducted by the research team. In each of the investigated cities, members of the team collected existing data, gathered evidences from the literature and rounded the collection up with discussions with local specialists, so as to provide an accurate view of the matters in each sampled city.

Table 1 shows some national-level development, vulnerability, adaptive capacity and governance indicators and indices for the six studied countries (cities) in Africa. These are used as proxies in the absence of specific city-level indices. The rationale for the framework used to reach the results in Table 1 is based on the need to provide a detailed account of trends related to the socio-economic, development, vulnerability and adaptive capacity to climate change of the cities investigated.

The ND-GAIN (ND) Country Index (VR) summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. Vulnerability measures a country's exposure (Ex), sensitivity and ability to adapt (AC) to the negative impact of climate change in life-supporting services, where Ex is the nature and degree to which a system is exposed to significant climate change, independent of socioeconomic context, and AC is the availability of social resources for sector-specific (current or potential) adaptation capacities. The score of Human habitat (HH) captures a country's vulnerability of human living conditions to climate change, considering weather extremes, urban development, demography, and transport infrastructure. Governance readiness (GR) captures the institutional factors that enhance the application of investment for adaptation, and GR* (adjusted for GDP by the distance of a country's measured ND score and its expected value based on the regression of ND-GAIN and GDP per capita). Positive values reflect lower vulnerability, better resilience and higher readiness than expected, given a certain level of GDP per capita (ND-Gain, 2017).

The climate stressors, climate vulnerability and risks, and the adaptation measures, policies, and strategies of the studied cities are summarized in Table 2. Table 2 is a detailed exposition of the climate trends of the various cities already documented in Table 1. It further describes the climate stressors, vulnerability and risks seen in each city on the one hand, as well as the impacts, and adaptation strategies used

Table 1
Socio-economic, development, vulnerability and adaptive capacity to climate change and hazards status of studied African Countries (National level). Classification index: poverty [a] (Gross Domestic Product-GDP; Pov: % of people living on USD 1.90 per day - Very High, High, Moderate, Low); UN Development status-UNDS [b] (Developing-Dev; Medium-Med; Least Developed Country-LDC; overall development placement-OD based on i,ii, and iii) [c]; Human Development Index (HDI, 2016) [b] (Very High-VH, High-H, Medium-Md, Low). Notre Dame Gain Index [d] of vulnerability (Vulnerability & Readiness-VR; Human Habitat – HH; Exposure-Ex; Adaptive Capacity-AC, Governance readiness-GR, and GR* adjusted for GDP.
Source: a. Poverty (data.worldbank.org/topic/poverty, Databank.worldbank.org.) and People below poverty line (www.indexmundi.com/g/r.aspx?v=69); b. Development classification and HDI: World Bank Group Development Economics Data Group, 2016. Policy Research Working Paper 7528 The World Bank's Classification of Countries by Income, retrieved from c. International Monetary Fund World Outlook 2016 (http://statisticstimes.com/economy/countries-by-projected-gdp-capita.php; d: ND-Gain (2017).

	GDP per capita (2016)[a]	i) % of people living on U$ 1.90 per day, ii) UNDS, iii) HDI and iv) overall development	ND-Gain overall vulnerability (Vul), (HH), (Ex), (AC), and (GR) to climate change and climate-related hazards (lower placements are better)		
	Parity Purchase Power (PPP)[c]	Pov - UNDS - HDI	HH VR	Ex AC GR GR*	
World average: 17,156		OD (relative placement among the studied countries)	ND-Gain Index. Relative placement in of the studied countries is indicated among 192 world countries		
Selected Countries					
Cameroon	3,358	VH - Dev - Low (3rd)	155th 137th	121st 147th 164th	96th
Ethiopia	2104	H - LDC - Low (5th)	141st 163rd	161st 159th 155th	137th
Ghana	4650	Med - Dev - Med (1st)	141st 101st	116th 99th 89th	59th
Kenya	3,507	VH - Dev - Med (2nd)	143rd 151st	159th 144th 147th	134th
Nigeria	5,960	VH - Dev - Low (4th)	125th 145th	116th 141st 171th	157th
Tanzania	3296	VH - LDC - Low (6th)	122th 150th	153rd 155th 119th	121st

in the studied cities, on the other.

Various policies have been adopted to date, by the respective cities to tackle the impacts of climate change. Table 3 presents a summary of some of the major policies and the main constraints related to their implementation.

Furthermore, these cities are engaged in regional agreements and bilateral arrangements with developed countries and institutions with a focus on technical and financial assistance, as well as strategies for successful policy implementation. A notable regional intervention is the Africa Adaptation Programme (AAP). AAP has been aiding African cities in terms of enhancing scientific capacity, sensitization of policy-makers, incorporating climate knowledge in education, and development policies (UNDP, 2017). Similarly, some of the cities have joined the 100 resilient cities (100RC) Network, which is focused on helping cities become more resilient to physical, social and economic challenges.

4. Discussion and policy implications

4.1. National-level development, vulnerability and readiness indices

The extent of the climate vulnerability in any given place will depend on the frequency and intensity of extreme events, the fraction of exposed people, its development, wealth and economic conditions (e.g. GDP, poverty), prevailing political institutions (e.g. GR), and the political will to prioritize adaptation strategies (Leal Filho et al., 2017; Villamizar et al., 2017). Table 1 shows that the studied countries are below the world average development, ranging from Nigeria (GDP-PPP U$ 5,960, but very high poverty and low HDI), to LDC and low HDI countries such as Ethiopia (PPP: U$ 2104) and Tanzania (PPP: U$ 3296). Only Ghana (U$ 4650) shows medium development levels.

The national-level indicators are required for use of international organizations, whilst local-level index is required by national and local-level governments (Vincent, 2007). However, due to the lack of appropriate comparative indicators for the studied cities, the national-level indexes are used as proxies. The use of indicators is one means of quantifying adaptive capacity for the use of policy-makers (Vincent, 2007).

Correlating ND scores with GDP per capita from Table 1 to produce adjustment (GR*) provides insight into a country's performance. For instance, Nigeria has the best PPP and the worst GR, while Ghana (PPP 2nd, and GR 1st) shows coherence. In brief, Ghana shows the best indicators among the studied countries in Exp, AC and GR, and is second to Nigeria in GDP (PPP), hence it's placed first in VR. If only GDP (PPP) and GR are considered, also Kenya is at a similar or even better overall placement than Nigeria. However, Nigeria's performance is not completely representative of Lagos', which is complementing the national adaptation initiatives with its dedicated city-level plans. The worst placed are Ethiopia and Tanzania which show very poor indicators for GDP, development and VR, particularly AC. When it comes to the adjusted GR for GDP, Ghana is the only GR* (59th) positive case (readiness and resilience better than expected from GDP) and placed better than the world average, while Nigeria (157th) shows the worst negative anomaly.

4.2. Experiences from the case studies

The experiences gathered from the individual case studies reveal a number of trends. Many of the policies across various cities and the challenges being faced in the implementation of these policies are similar. Also, the cities tend to adopt climate policies being implemented at the national level, and only a few of them have mechanisms at the local level (e.g. city-wide climate programmes). This is largely because most international adaptation assistance and finance are targeted at country-level interests rather than city level. The absence of strong financial support at the local level makes it difficult to implement and sustain independent climate policies for individual African cities. Furthermore, developing sound city-level policies to respond effectively

Table 2
Climate stressors, vulnerability, risks, impacts, and adaptation in the studied cities.

City	a) Climatic stressors, vulnerability, and risks b) Impacts c) Example of adaptation strategies.	References
Douala	a) Rainfall changes, sea-level rise increased storm surges and flooding. Heavy precipitation during the rainy season (June-October) and increased temperature and droughts during dry seasons	Dapi et al. (2010); Leal Filho et al. (2017)
	b) An increase in heat-related health problems (e.g. fainting)	Diko (2012); Enete et al. (2013)
	c) The National Centre of Climate Change has institutionalized disaster risk reduction (DRR). The Community-Based Disaster Management guidelines support the threatened communities in order to enhance the response to DRR.	Leal Filho et al. (2017); Tosam and Mbih (2015); Yengoh et al. (2017)
Lagos	a) Sea-level rise. An increased intensity of storm surges and flooding, increased heavy rainfall, increased temperature	Elias and Omojola (2015); Neumann et al. (2015); Oshodi (2013);
	b) Low-lying and coastal regions are among the most vulnerable to climate change, which is exacerbated by the high population density and poverty. Flooding will diminish the quality and quantity of potable water. Warming affects human health, in addition to the poor drainage system, which breeds harmful disease vectors;	Cabral et al. (2017); LAS-CCAS (2012)
	c) Adaptation is very poor due to the absence of strong institutions to enhance adaptive capacity.	Komolafe et al., 2014; ND-Gain Index (2016)
Accra	a) Flooding	Codjoe et al. (2014);
	b) Accra faces structural challenges associated with high-density, low-infrastructure areas where poor residents face climate-related threats due to the lack of adequate floodwater protection infrastructure, education, and health facilities	Codjoe and Issah (2016)
	c) The National Climate Change Adaptation Strategy (NCCAS) sets forth adaptation goals focused on reducing vulnerability among the population and ecosystems.	Codjoe et al. (2014); MESTI (2013); UNDP (2012)
Dar-es-Salaam	a) Sea-level rise combined with flooding. Heavy rainfall related primarily to ENSO events. Droughts	Boamah et al. (2015);
	b) Increased vulnerability due to life in unplanned settlements, especially to water-borne and vector-borne diseases	Baker (2012); Sakijegeje (2017)
	c) Adaptation initiatives are i) Resident-level place-specific actions to reduce the development deficit against flooding, and ii) Government-level formalized infrastructure development focused on reducing vulnerability and improving resiliency against storm surge and sea-level rise.	Armah et al. (2015); Bulkeley and Tufts (2013); Gore (2015); Kiunsi (2013); TVPO (2007)
Mombasa	a) Sea-level rise and storm surges;	Kebede et al. (2012);
	b) Informal settlements at risk, waste management problems, water- and vector-borne diseases	Kebede et al. (2012)
	c) An Integrated Coastal Zone Management Action Plan (2011 – 2015) was implemented in order to regulate coastal developments;	Awuor et al. (2008); Bichnell et al. (2009); NEMA (2010); Puthucherril (2014)
Addis Ababa	a) Heavy rainfall and flooding are expected to increase. Increased temperature creates Urban Heat Island (UHI);	NMA (2007);
	b) Change in vegetation cover causing local warming. Damages to property along streams flowing down the nearby hills. UHI affects human health	Woldeamlak and Conway, 2007) Kahsay (2016).
	c) An urban and infrastructure flood protection scheme including structural and non-structural adaptation actions to be implemented over a 15-year period.	Dubbale et al. (2010); Kahsay (2016); UN-HABITAT (2011)

to climate risks requires strong institutional leadership. Unfortunately, institutional failure in tackling climate challenges at the grassroots has been identified as a common problem across several African cities (Adenle et al., 2017). Most adaptation initiatives in the continent are targeted at national level issues with limited city and local engagement (Ford et al., 2015). This is not limited to African cities. In a global survey of 401 cities, only 73 cities (18%) had documented plans aimed at initiating adaptation policy (Araos et al., 2016). Interestingly, Lagos is one exception to this trend and has a climate change policy specific to the city in addition to the national policy. This is probably due to its status as a mega-city with a population exceeding 20 million as well as its strong financial status, being the economic capital of oil-rich Nigeria. However, it is ideal to align city level adaptation plans with country level priorities to avoid fragmented implementation which could limit the effectiveness of proposed policies, create confusion, and limit opportunities for mainstreaming (Adenle et al., 2017). From the constraints identified in Table 3, it is evident that many African cities do not have the necessary infrastructure needed in order to cope with climate change. This helps to explain their vulnerability. However, the significance of dealing with climate change adaptation is recognized by the various stakeholders in all studied cities. Even though it is widely known that climate change adaptation measures should involve various stakeholders (Mimura, 2013; Archer et al., 2014), this is in practice very challenging in Africa, because most big cities, including those studied herein, are established in hazard-prone locations (Mendelsohn and Saher, 2010). Lessons could be drawn from various soft and hard climate adaptation practices to minimize and manage the impacts in cities (Berry, 2016).

Similarly, while the sampled cities participate in some international climate change programmes such as the AAP and UNFCCC national calls, they do not take part in a number of other vital initiatives on climate change impacts on cities, such as the Medellin Collaborations on Urban Resilience, UN Habitat's City and Climate Change Initiative and Academy, UNISDR'S Global Resilience Cities Campaign (Simon and Leck, 2015) which have emerged over the years. This is a deficiency that needs to be tackled. Commendably, three of the studied cities have recently joined the 100RC Network. Accra, Addis Ababa, and Lagos now have the opportunity to leverage 100RC's interventions designed for member cities to enhance resilience to shocks and stresses. 100RC's focus on social and economic stresses such as high unemployment; inefficient public transportation system; endemic violence; and chronic food and water shortages aligns with the major challenges of the studied cities.

4.3. Adaptation approaches and governance

Moreover, it is essential to diversify current approaches. The integration of bottom-up and top-down approaches provides structure to

Table 3
Summary of major policies, constraints and implementation.

City	Policy	Year	Policy Thrust	General Constraints to implement CC adaptation policies (All Cities)	References
Douala	National Environment Management Plan (NEMAP) PRSP process National Adaptation Plan of Action (NAPA) Initial National Communication (INC)	1995 1999 2005 2005	Sustainable industrial development; combating environmental degradation; reducing GHG emissions; promoting alternative energy sources Poverty reduction to strengthen adaptation capacity Promote climate-sensitive natural resource-based livelihoods GHG reduction mechanisms; monitor and evaluate socioeconomic and environmental impacts related to CC	Poor Funding Lack of public awareness and support Weak institutions. Infrastructural decay Unskilled manpower Poor integration (strategies & institutions) Poor research framework Political, legislative, fiscal and resource constraints Lack of adaptive capacity Adaptation progress has proven to halt	Wouapi et al. (2014); Adaptation Partnership (2011)
Lagos	Lagos State Climate Change Policy (LSCCP)	2012	Adaptation and mitigation; sustainable development; Controlling unplanned Rapid urbanization; disaster risk management; education and awareness; develop economic, social and environmental resilience; Develop a flood and storm warning system; protect biodiversity and reduce erosion; promote afforestation and alternative energy sources; Develop and promote climate change proofed infrastructure standards and codes; integration of climate change risk in housing development policies and projects; access to healthcare services.		LAS-CCAS (2012)
Accra	Ghana National Climate Change Policy (GNCCP)	2012	Develop climate resilient agriculture; Build Climate Resilient Infrastructure; Increase Resilience of Vulnerable Communities		Ministry of Environment Science and Technology and Innovatio (2013)
Dar-es-Salaam	National Adaptation Programme of Action (NAPA)	2007	Improve resilience; Reduce the infrastructural deficit and vulnerability against sea-level rise and flooding		Armah et al. (2015); Kiunsi (2013); TVPO (2007)
Mombasa	Integrated Coastal Zone Management Action Plan	2010	Environmental law enforcement; Monitoring of sea-level rise and flooding; Management of resources; Building community adaptive capacity.		Bichnell et al. (2009); Puthucherril (2014)
Addis Ababa	Environment Policy of Ethiopia Ethiopian Programme of Adaptation to Climate Change (EPACC) Climate-Resilient Green Economy (CRGE) Strategy	1997 2010 2011	Promoting a climate monitoring programme Integrate climate change into national-level policies; drought control; Build Climate Resilient Infrastructure; early warning system Improved Agriculture; Energy efficient transportation and buildings		Bryan et al. (2009); LSE (2017)

hazard, vulnerability and capability assessment by involving various stakeholders and prioritizing adaptation options and target groups (Bhave et al., 2014). Specifically, the bottom-up approach facilitates engagements with relevant stakeholders and considers the nature and magnitude of social, economic and ecological states of present vulnerabilities induced by multiple stressors thereby making informed decisions to manage future risks (Brooks et al., 2005). Likewise, the top-down approach provides information which could shape climate adaptation options and priorities of stakeholders.

In respect of governance, the studied cities show that the role of city authorities in climate change adaptation should be centralised. For instance, they could play important roles in the integration of climate adaptation strategies with national development plan (NAPAs), implementation of policies and strategies, establishing partnerships with pertinent stakeholders, and help in the mobilising the wider community to implement climate adaptation measures (Shaw and Okazaki, 2004). However, findings from this study align with earlier studies, which reveal that these adaptive initiatives are hampered by limited financial resources, skills, and access to timely information, which are essential for implementing various post-disaster measures (McCarney et al., 2011; IPCC, 2014; UNISDR-AF, 2014). Hence, building the capacity of city administration and authorities is crucial to building climate resilient communities and largely sustainable interventions (Shaw and Okazaki, 2004; Rajeev, 2014).

Furthermore, managing the complex impacts of climate change requires a multi-scalar and multi-sectoral partnership of stakeholders with diverse capabilities and expertise. Partnerships are required to bring together various stakeholders such as government, NGOs, civil societies, research institutes and universities to implement effective and efficient climate change adaptation measures (Máñez Costa et al., 2013). Relevant government agencies should take the lead in designing adaptation, as well as coordinate its implementation.

Building good governance is the corner-stone of implementing effective and efficient climate change adaptation measures (Birkmann et al., 2010; Baker, 2012). This facilitates effective climate risk identification, prioritization, and implementation of adaptation measures (Garmestani and Benson, 2013). It enables the active collaboration of government agencies, NGOs, private sectors, individuals and the wider community thereby creating a sense of ownership and contributing to the sustainability of adopted measures (Geoff et al., 2010). In contrast, the absence of good governance will erode stakeholder trust and capability thereby worsening the impact of climate change in the context (IPCC et al., 2012). The studied cities and countries are poorly placed in terms of governmental readiness (see Table 1). For instance, Cameroon's vulnerability and adaptive capacity seem to be both over and underestimated due to governance indicators (Leal Filho et al., 2017).

Without effective implementable measures to reduce vulnerability, the current risk of disasters in African cities may increase, since the degradation of infrastructure and facilities worsen current exposure. This trend also has the potential to magnify the uneven distribution of risk amongst both the poor and those with wealth. There are a few comprehensive studies that capture damage, adaptation, and residual costs incurred as a result of climate change and as such, the full socio-economic and environmental costs are often underestimated (IPCC et al., 2012).

Given that many of the challenges ahead are of a trans-boundary nature, it is necessary to foster local, national and regional cooperation among African cities and nations in order to find a lasting solution to the climate change scourge bedeviling the continent (UN-Habitat, 2014).

5. Conclusions, lessons learned and recommendations

This study has a set of limitations. The first one is the fact that it could only cover a small number of African cities. Secondly, the data gathered only offer a profile of current trends and does not provide

historical data. Nonetheless, the study provides a timely contribution towards an understanding of the policy gaps and problems African cities face in their attempts to cope with the impacts of climate change, also emphasising the positive influence of policies in the adaptation process. The main conclusions which can be drawn from the work, lessons learned and recommendations, now follow.

5.1. Climate and development threats, and governance

There is a strong relationship between climate change and development. Hence, there is a need to understand the socio-economic drivers of risks associated with climate change. As African cities continue to grow, city authorities need to integrate current and future city development plans with climate change mitigation and adaptation strategies, while also enhancing the adaptive capacity of the vulnerable urban population.

Beyond the exposure of the studied cities to warming, sea level rise, river and sea floods, related to their hazard-prone locations, there are several synergic non-climate drivers and constraints to manage the observed and expected impacts. Some of them are:

(i) rapid population growth;
(ii) moderate to high levels of poverty;
(iii) environmental degradation and lack of adequate sanitation infrastructure

These factors, in turn, lead to high vulnerability and a reduced capacity to adapt. The vulnerability and adaptive capacity of the studied countries place them among the lowest ranked ones for human habitat among 192 world countries (from 122th to 155th). The studied countries show high levels of exposure (from 116th to 161st) and poor adaptive capacity to cope with climate change and hazards (from 99th to 159th, and governance readiness: from 89th to 171th). The overall ND vulnerability-readiness placement (from 101th to 163rd) decreases from Ghana to Cameroon, Kenya, Tanzania, Nigeria and Ethiopia.

The lack of well-established governance systems also contributes to the low adaptive capacity. An indication of how well African countries may perform is seen in Ghana, rated at 89th (59th if adjusted for GDP) above the other studied countries and the world average, and fourth in Africa, which is in close agreement with the recent positive evolution of Ghanaian adaptation plans (e.g. NAPA, NCCAS, NCCP) which are promising prospects.

5.2. Lessons learned

One of the major lessons gathered from the case studies presented in this paper is that some of the key factors to foster climate management in African cities beyond the climate threats are: the strengthening of institutions, well designed national and city-level planning and governance.

In addition, the case studies have shown that despite promising adaptation prospects designed to cope with climate change and hazards, the results of many of the implemented measures and strategies are weak, or often innocuous leading to no real improvements. For instance, there is little evidence to suggest that substantial adaptive approaches are being effectively implemented in much of Accra itself.

Moreover, evidence of the impacts of the promising and new climate management initiatives in the studied cities can only be gathered, once they are implemented, monitored and evaluated.

Finally, there is a direct relationship between a city's developmental status and its adaptive capacity. Well planned cities with good infrastructure are better equipped to adapt to climate changes with minimal destructive impacts, which shows that investments in this field are worthy.

5.3. Policy-related recommendations

Leveraging experiences from other continents could provide a valid framework for African cities' resilience-building efforts at minimal cost. However, based on this study which essentially had a focus on African cities' climate change adaptation measures, concrete steps in the field of policy-making need to be taken, in order to holistically address the peculiar challenges being faced by each city. For instance, Addis Ababa's water insecurity, which is not adequately addressed in the national level NAPA document, underscores the need for strong city-level policies that will comprehensively address its unique challenges. Climate adaptation initiatives will also require interventions in water policies to succeed (Okpara et al., 2018). Due to Tanzania's low-ranking placement in the poverty, human and infrastructural development indices in Table 1, Dar-es-Salam should be highly prioritized in future disbursement of international donors' adaptation finances to African cities. Accra on the other hand is not as financially challenged as most other cities in Africa. The city should leverage Ghana's above-average Governance Readiness (GR) status to catalyse city level awareness on climate change. This can be actualized through extensive consultation with the major stakeholders and formulating sustainable city level policy processes that will prioritize relevant adaptation activities based on the city's specific challenges and needs. To make its existing city level climate change policy more effective, Lagos needs to invest massively in infrastructural development particularly around the many slums in the city. The city's huge population of poor residents inhabiting several unplanned informal settlements are highly vulnerable to climate change impacts. Providing good drainage system and piped water through sustained urban renewal will minimize impacts of flooding and water-borne diseases thereby enhancing resilience to climate change impacts. Mombasa, being a coastal city like Lagos faces similar challenges and will also benefit from urban renewal targeted at infrastructural development.

In addition to the above city-specific adaptation measures, some generic recommendations may be made across all the studied cities since many of the challenges being faced are trans-boundary and similar:

- strengthen city administrations' financial capacity to invest more on climate resilience, and enabling them to implement climate related policies;
- improve local authorities' skill and knowledge on the impacts of climate change to guide preventive action;
- foster partnerships among public and private stakeholders in the implementation of adaptation policies and strategies;
- facilitate the adoption of feasible –if possible indigenous technologies- and further develop green infrastructure;
- promote good governance;
- integrate climate change adaptation strategies with the urban development plan and disaster risk management within NAPAs.

This list of recommendations is by no means comprehensive but captures some of the areas where an action is most needed. With the current emphasis being given to the UN Sustainable Development Goals (SDGs) especially SDG 11 (Sustainable cities and communities), a window of opportunity is open to African cities which should be used.

Ongoing initiatives such as the Tanzanian ICZM and NAPA, the Addis Ababa government green developments, and the Ghanaian government plans, are well-tried frameworks for the assessment and needed integration of climate impact, adaptation, land planning and disaster risk reduction. They may be useful and, with some degree of adaptation, suitable for replication at other cities in Africa.

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